

**NASA**

**SECTION 1**

## Michele Lewis

---

**From:** McDede-1, James [James.McDede-1@ksc.nasa.gov]  
**Sent:** Tuesday, January 21, 2003 10:10 AM  
**To:** ROE, RALPH R. (JSC-MV) (NASA); PETETE, PATRICIA (TRISH) (JSC-MV) (NASA);  
SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA); SHACK, PAUL E. (JSC-EA42) (NASA);  
James.Wilder@USAHQ.Unitedspacealliance.com; Reeves, Bill  
**Subject:** FW: ET Briefing - STS-112 Foam Loss  
**Importance:** High



ET Briefing.pdf

FYI -

> -----Original Message-----

> From: Cowart-1, Jon  
> Sent: Tuesday, January 21, 2003 10:02 AM  
> To: Alison Dinsel-1 (E-mail); Bryan Banks (E-mail); Dean Kunz  
(E-mail);  
> Eddie Lackey (E-mail); James McDede (E-mail); John Gurecki (E-mail);  
> Robert Abbott (E-mail)  
> Subject: FW: ET Briefing - STS-112 Foam Loss  
> Importance: High

> -----Original Message-----

> From: Sheehan, Gerald  
> Sent: Tuesday, January 21, 2003 9:53 AM  
> To: EXT-Abner, Charlie A #KSCEMS; EXT-Herman, Robert S; Bell, Dan  
R.;  
> Holmes, Stephen E.; Madden, Craig J.; McCarley, Michael C.;  
Mulholland,  
> John P; Muhar, M M; Engle, James M.; Luecking, Robert B.  
> Cc: Fuller, Mike J.; Cabe, William; Crawford, Johnny; Leonard, Wil;  
> Seraphine, Alan  
> Subject: FW: ET Briefing - STS-112 Foam Loss  
> Importance: High

> All-

> ....just to jog my memory, I asked Kim to pull the STS-113 FRR  
> briefing from ET on the last time they lost part of the bipod SLA  
closeout  
> (on STS-112/ET-115). FYI  
> GDS

> -----Original Message-----

> From: Cochran, Kimberlee D.  
> Sent: Tuesday, January 21, 2003 9:40 AM  
> To: Sheehan, Gerald  
> Subject: ET Briefing  
> Importance: High

> <<ET Briefing.pdf>>

> Kim Cochran  
> Technical Publications  
> 321.861.4627  
> 721Z-K084



**SPACE SHUTTLE PROGRAM**  
**Space Shuttle Projects Office (MSFC)**  
NASA Marshall Space Flight Center, Huntsville, Alabama

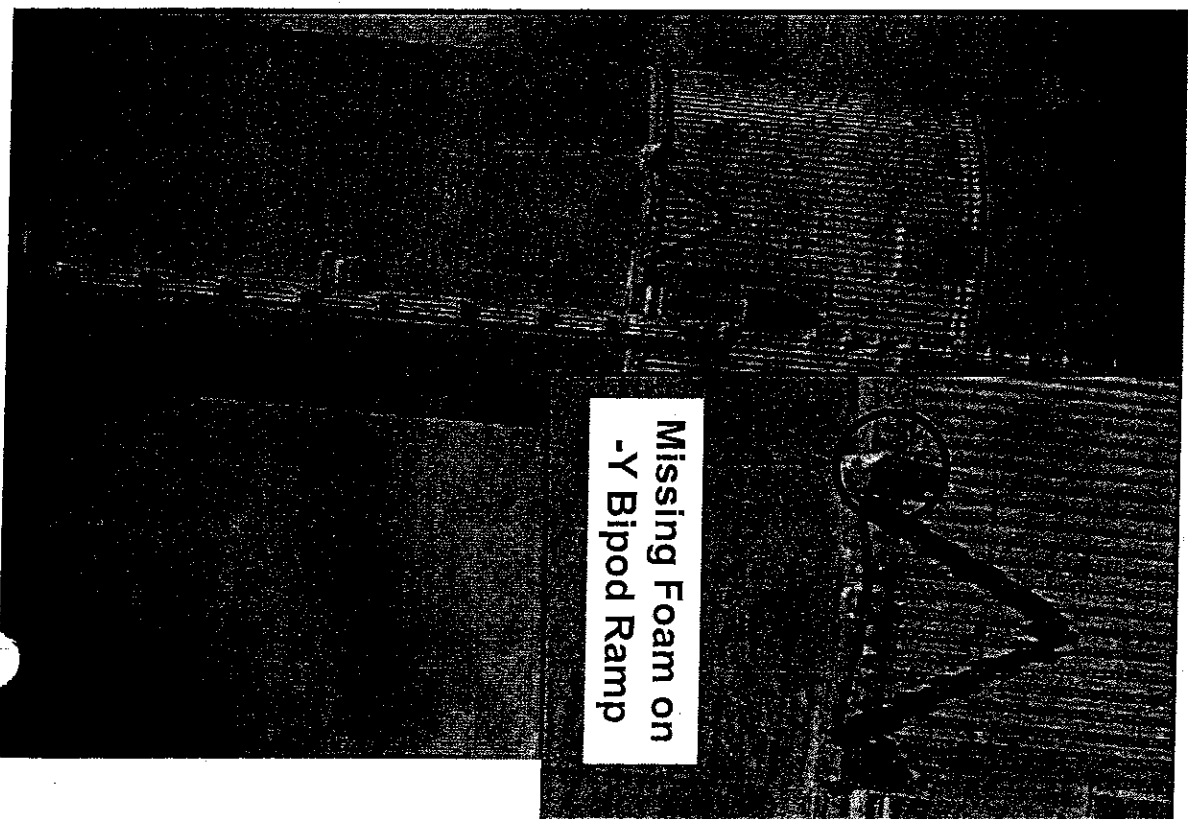


**STS-112/ET-115 Bipod Ramp Foam Loss**

Presenter Jerry Smelser, NASA/MP31

Date October 31, 2002 Page 3

- Issue
  - Foam was lost on the STS-112/ET-115 -Y bipod ramp ( $\approx 4'' \times 5'' \times 12''$ ) exposing the bipod housing SLA closeout
- Background
  - ET TPS Foam loss over the life of the Shuttle Program has never been a "Safety of Flight" issue
  - More than 100 External Tanks have flown with only 3 documented instances of significant foam loss on a bipod ramp





# SPACE SHUTTLE PROGRAM

## Space Shuttle Projects Office (MSFC)

NASA Marshall Space Flight Center, Huntsville, Alabama



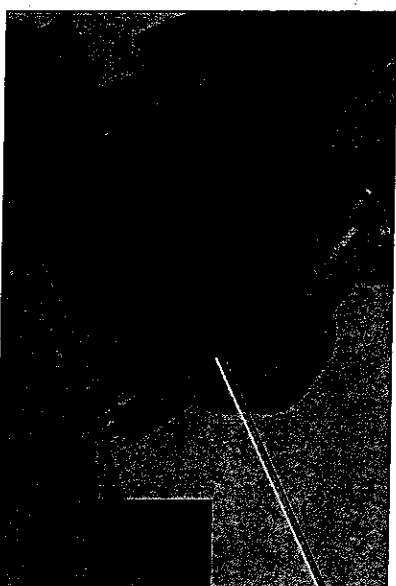
### STS-112/ET-115 Bipod Ramp Foam Loss

Presenter Jerry Smelser, NASA/MP31

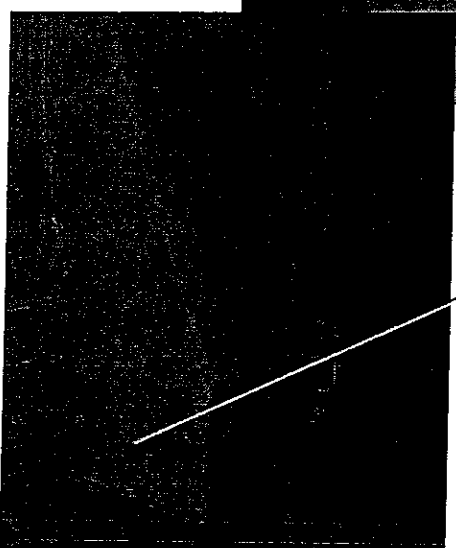
Date October 31, 2002 Page 4

#### • Rationale for Flight

- Current bipod ramp closeout has not been changed since STS-54 (ET-51)
- The Orbiter has not experienced "Safety of Flight" damage from loss of foam in 112 flights (including 3 known flights with bipod ramp foam loss)
- There have been no design / process / equipment changes over the the last 60 ETs (flights)
- All ramp closeout work (including ET-115 and ET-116) was performed by experienced practitioners (all over 20 years experience each)
- Ramp foam application involves craftsmanship in the use of validated application processes
- No change in Inspection / Process control / Post application handling, etc
- Probability of loss of ramp TPS is no higher/no lower than previous flights
- *The ET is safe to fly with no new concerns (and no added risk)*



Prior to Foam Closeout



After Final Foam Trim

Bipod Attach Fitting

**Michele Lewis**

---

**From:** RICKMAN, STEVEN L. (JSC-ES3) (NASA)  
**Sent:** Tuesday, January 21, 2003 10:37 AM  
**To:** KOWAL, T. J. (JOHN) (JSC-ES3) (NASA); CURRY, DONALD M. (JSC-ES3) (NASA)  
**Subject:** FW: STS-107 Debris Analysis Team Plans

Don, John: Do you or your teammates have any information about maximum allowable debris hits (size and velocity) for the vehicle? Has any of this been held up against what was seen in the launch film footage?

Question for John: If there is significant damage to the tiles on the belly, does this lead to early transition to turbulent heating?

Steve

-----Original Message-----

**From:** SHACK, PAUL E. (JSC-EA42) (NASA)  
**Sent:** Tuesday, January 21, 2003 9:33 AM  
**To:** ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA)  
**Cc:** KRAMER, JULIE A. (JSC-EA4) (NASA); MILLER, GLENN J. (JSC-EA) (NASA); RICKMAN, STEVEN L. (JSC-ES3) (NASA); MADDEN, CHRISTOPHER B. (CHRIS) (JSC-ES3) (NASA)  
**Subject:** RE: STS-107 Debris Analysis Team Plans

This reminded me that at the STS-113 FRR the ET Project reported on foam loss from the Bipod Ramp during STS-112. The foam (estimated 4X5X12 inches) impacted the ET Attach Ring and dented an SRB electronics box cover.

Their charts stated "ET TPS foam loss over the life of the Shuttle program has never been a 'Safety of Flight' issue". They were severely wirebrushed over this and Brian O'Conner (Associate Administrator for Safety) asked for a hazard assessment for loss of foam.

The suspected cause for foam loss is trapped air pockets which expand due to altitude and aerothermal heating.

-----Original Message-----

**From:** ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)  
**Sent:** Monday, January 20, 2003 8:47 PM  
**To:** SHACK, PAUL E. (JSC-EA42) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA)  
**Cc:** KRAMER, JULIE A. (JSC-EA4) (NASA); MILLER, GLENN J. (JSC-EA) (NASA); RICKMAN, STEVEN L. (JSC-ES3) (NASA); MADDEN, CHRISTOPHER B. (CHRIS) (JSC-ES3) (NASA)  
**Subject:** FW: STS-107 Debris Analysis Team Plans

FYI on forthcoming activity. From USA/Pam Madera and her talking to Boeing contacts:

- It appears that the image folks can only state the impactor is 20 inch max dimension plus/minus 10 inch. It has a max thickness of about 4 inch or so due to the known thicknesses of the ET insulation in the forward bipod area.
- Boeing Load/Stress group is researching if such insulation impacts are in the data base of previous impact tests on Orbiter TPS.

**Rodney Rocha**

- Division Chief Engineer (DCE), ES-Structural Engineering Division
- Chair, Space Shuttle Loads & Dynamics Panel
- Mail Code ES2                      x38889

- Boeing Load/Stress group is researching if such insulation impacts are in the data base of previous impact tests on Orbiter TPS.

**Rodney Rocha**

- **Division Chief Engineer (DCE), ES-Structural Engineering Division**
- **Chair, Space Shuttle Loads & Dynamics Panel**
- **Mail Code ES2      x38889**

: Madera, Pamela L [mailto:pam.l.madera@usahq.unitedspacealliance.com]

**Sent:** Monday, January 20, 2003 5:47 PM

**To:** CURRY, DONALD M. (JSC-ES3) (NASA); ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA); LEVY, VINCENT M. (JSC-EG) (NASA); KOWAL, T. J. (JOHN) (JSC-ES3) (NASA); DERRY, STEPHEN M. (STEVE) (JSC-EG3) (NASA)

**Cc:** 'Scott Christensen V (E-mail)'; 'Norman Ignacio (Nacho) (E-mail)'; CHAO, DENNIS; Stoner-1, Michael D; 'Carlos Ortiz (E-mail)'; 'Michael J Dunham (E-mail)'; Sebesta, Stephen P; CORONADO, DIANA; 'Craig Madden' (E-mail); Bell, Dan R.; Gordon, Michael P.; Paul A Parker (E-mail)

**Subject:** STS-107 Debris Analysis Team Plans

The Boeing/USA team would like to meet with you Tuesday at 2:00 on meet-me-line number to discuss analysis plans for assessing the STS-107 Debris Impact.

*Pam Madera*

Vehicle and Systems Analysis Subsystem Area Manager

Phone: 281-282-4453

**Michele Lewis**

---

**From:** Robert H. Daugherty [robert.h.daugherty@nasa.gov]  
**Sent:** Monday, January 27, 2003 4:35 PM  
**To:** CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)  
**Subject:** Video you sent

WOW!!!

I bet there are a few pucker strings pulled tight around there!

Thinking about a belly landing versus bailout..... (I would say that if there is a question about main gear well burn thru that its crazy to even hit the deploy gear button...the reason being that you might have failed the wheels since they are aluminum..they will fail before the tire heating/pressure makes them fail..and you will send debris all over the wheel well making it a possibility that the gear would not even deploy due to ancillary damage...300 feet is the wrong altitude to find out you have one gear down and the other not down...you're dead in that case)

Think about the pitch-down moment for a belly landing when hitting not the main gear but the trailing edge of the wing or body flap when landing gear up...even if you come in fast and at slightly less pitch attitude...the nose slapdown with that pitching moment arm seems to me to be pretty scary...so much so that I would bail out before I would let a loved one land like that.

My two cents.

See ya,

Bob

At 03:04 PM 1/27/2003, you wrote:

-----Original Message-----

**From:** SMITH, JAMES P. (JSC-ES2) (NASA)  
**Sent:** Wednesday, January 22, 2003 7:15 AM  
**To:** DL ES2 Branch; DL ES2 Contractors  
**Subject:** FW: STS-107 Post-Launch Film Review - Day 1

Watch the video first and see if you can spot anything.

**Michele Lewis**

---

**From:** CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)  
**Sent:** Friday, January 31, 2003 4:58 PM  
**To:** GALBREATH, GREGORY F. (GREG) (JSC-ES2) (NASA)  
**Cc:** ROGERS, JOSEPH E. (JOE) (JSC-ES2) (NASA)  
**Subject:** WAR

**SPACE SHUTTLE ORBITER  
STS-107 Debris Impact Damage**

In order to alleviate concerns regarding the worst case scenario which could potentially be caused by the debris impact under the Orbiter's left wing during launch, EG conducted some landing simulations on the Ames Vertical Motion Simulator which tested the ability of the crew and vehicle to survive a condition where two main gear tires are deflated before landing. The results, although limited, showed that this condition is controllable, including the nose slap down rates. These results may give MOD a different decision path should this scenario become a reality. Previous opinions were that bailout was the only answer.



**Michele Lewis**

---

**From:** Bell, Dan R. [DRBell@xch-bsco-06.ksc.nasa.gov]  
**Sent:** Monday, January 27, 2003 3:52 PM  
**To:** KOWAL, T. J. (JOHN) (JSC-ES3) (NASA)  
**Subject:** Ascent impact on OV-104

John,

I talked to the MEQ guy's regarding a hit in the MLGD area earmarked on the charts. Their response was that Dryden is a safer place to put the vehicle down if a gear/tire issue were to occur prior to touchdown. The stopping distance should not be an issue because the break energy transfers to the tires after wheel stop. I again have to fall back on the film guys assessment that the impact occurred outboard of the MLGD area.

Dan Bell  
TPS SSM  
(321)861-4617

## Michele Lewis

---

**From:** Bell, Dan R. [DRBell@xch-bsco-06.ksc.nasa.gov]  
**Sent:** Wednesday, January 22, 2003 7:34 AM  
**To:** Barnum, Keith; Bell, Dan R.; Brand, Jeremy H.; Bray, Mark H.; Carter, Randall E.; Chaffey, Michele L.; Chao, Dennis C.; Cooley, Phil M.; Cottle, William W.; Courter, Jon; 'Dan Leiser'; BARRETT, GERO L. (JSC-MG) (USA); EXT-Curtis, Sherri D; EXT-Deem, Victoria J; EXT-Finnegan, Patrick J; EXT-Gill, Jennifer R #KSCEMS; EXT-Gorenflo, Gregory H; EXT-Henn, Beckey M; EXT-Huff, Joy N #KSCEMS; EXT-Jones, Frank E #KSCEMS; KOWAL, T. J. (JOHN) (JSC-ES3) (NASA); EXT-Laufenberg, Katherine M; EXT-Madera, Pamela L; EXT-Marino, Betty J; EXT-Meyer, Kimberlee H; EXT-Micklos, Ann M; EXT-Nielsen, Larry J; EXT-Olejarski, Michael J; ORTIZ-LONGO, CARLOS R., PHD (JSC-EA4) (NASA); EXT-Rhodes, Frank H; ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA); EXT-Romeo, Charles F; EXT-Rosenbauer, Lynn A; SCHOMBURG, CALVIN (JSC-EA) (NASA); EXT-Sebesta, Stephen P; EXT-Snider, Douglas C; EXT-Stoner-1, Michael D; EXT-White, Terrence R; EXT-Wilson, Martin J; EXT-Young, Frank; EXT-Zook, Lee M; ISHMAEL, MOHAMED I. (GEORGE) (JSC-NC) (SAIC); Gordon, Michael P.; Hausken, Jeff; Hinkle, Karrie A; Hollabaugh, Douglas G; Irons, Mary L.; Jain, Mahesh C; Kerios, Brenda C.; Kinder, Gerald R; Lubas, Dave L.; Madden, Craig J.; Mirdamadi, Ali R; Perez, Robert J; Porras-Jr, Carlos G; Reyes, John F; Reyes, Vince J; Sharifzadeh, Habib; Snapp, Cooper G.; Solomon, Marcella; Sorokin, Paul; Speed, Victor W.; Stenger-Nguyen, Polly; Steyer, Todd E; Syms, Bert E; Tipton, Bradford R.; Tran, Jenny B; Whong, Kong-Heng; Wong, Gordon F  
**Subject:** Foam Briefing attached



FoamPRT.ppt

Attached Briefing on replacement closeout foam discussed at yesterday's PRT.

---

# **Phase II Qualification Of A Non-141b Foam Blowing Agent For Orbiter**

**1/27/03**

UCN/MCR:23229  
PCIN:TBD  
Study: 1.7.8.1.1  
Implementation:1.7.8.1.5

Presenter: Keith Chong  
Study Leader: Eric Eichinger  
BNA SSM:Thomas Collins  
USA SAM:Cris Curtis

---

**ISSUE:**

- EPA Phase-out of HCFC-141b in 2003 Impacts Future Availability of Orbiter Foam Insulation

**OBJECTIVE:**

- Qualify an EPA Compliant HFC-245fa Blown Foam to MB0130-149

# **Shuttle Elements Use HCFC 141b Foam to Insulate Cryogenics**

---

## **BACKGROUND:**

- **HCFC 141b is Currently The Blowing Agent Blended in Orbiter, MB0130-149, PDL 1034-2.5 Foam Insulation**
  - The Blowing Agent Gas Solubility and Diffusion can Affect the Shrinkage or Dimensional Instability over Both the Short and Long Terms
  - The Blowing Agent Affects the Thermal Conductivity
- **PDL 1034-2.5 Foam is Used by Orbiter to Insulate MPS & PRSD (Power Reactant Supply & Distribution) Hardware**
  - Orbiter Half (LH<sub>2</sub>) & ET Half (LO<sub>2</sub>/LH<sub>2</sub>) Umbilical Disconnects
  - Small Cryogenic Lines (LO<sub>2</sub>/LH<sub>2</sub>)
  - Feedline Prevalves
  - 12-inch Flanges where SSMEs Attached to Orbiter Interface
- **HCFC 141b Foams are Used by Other Shuttle Elements**
  - ET Foams the Entire Tank (4 Foam Types)
  - SRB Uses the Foam for Plug Repairs and Segment Joints
- **NSTS 07700 Requires ET and Orbiter to Use same Foam Insulation**

# **HCFC-141b Phase-out is Around the Corner**

---

## **BACKGROUND: (Continued)**

- **EPA will Phase HCFC-141b out of Production by 1/2003**
  - Continue Use of Existing Inventory Allowed
- **The Orbiter Program is Waiting for EPA to Approve the Waiver**
  - Allows Continued Use and Production of HCFC-141b Blown Foam for Shuttle
  - Material Obsolescence Issues Remain
- **Currently, there is no "Drop-in" Substitute for Existing Foam**
- **Testing is Required to Locate a Replacement**
  - New HFC-245fa Blown Foam from Utah Foam Appears to Meet Screening Requirements of MB0130-149 Based on Boeing Sponsored Testing
  - Resources are Required to Perform the MB0130-149 Specific Testing for Foam Qualification

# **Utah Products 245fa Blown Foam Meets Pre-screening Tests**

---

## **ACTIONS TAKEN:**

- During Phase I, Funded by Boeing IAD, Several Potential Foam Candidates from Three Foam Formulators were Screened for Basic Foam Requirements before Proceeding to a Phase II Qualification Effort.
  - Density
  - Foaming Properties & Viscosity
  - Dimensional Stability at Elevated Temperature (275°F)
  - Plug-pull Adhesion on MB0125-055, Koropon Primed Surfaces at RT & -300°F
  - Closed Cell Content
  - Thermal Conductivity at RT & Low Temperature
- At the End of Phase I, M&PE has Determined that the X1826 (245fa Blown) Pour Foam from Utah Foam Products Warranted Phase II Testing
- M&PE is now Returning to the Orbiter Program with a Request for Resources to Attempt a Qualification

# Summary Data of Utah Foam X1826

Test	Phase	Status	MB0130-149 Requirement	Existing PDL 1034-2.5	New Utah X1826 Foam	Pass/Fail
Cream Time	I	Completed	25 – 60 sec	25 – 60 sec	44 sec	Pass
Rise Time	I	Completed	140 – 220 sec	140 – 220 sec	250 sec	Fail
Tack-free Time	I	Completed	180 – 300 sec	180 – 300 sec	280 sec	Pass
Density	I	Completed	2.2 – 2.8 lb/ft <sup>3</sup>	2.45 - 2.7 lb/ft <sup>3</sup>	2.69 lb/ft <sup>3</sup>	Pass
Plug Pull Adhesion on Primed Substrate	I	Completed	Not Applicable	79 psi (ave.) @ RT 53 psi (ave.) @ -300°F	*60 psi (ave) @ RT 39 psi (ave) @ -300°F	-
% Closed Cell	I	Completed	80 min.	84	94	Pass
Dimensional Stability (vol. Change) 48 hrs @ 275°F	I	Completed	±5% max.	4.24% 7.39%	6.4%	Fail
Vibration Study	I	In Work	No Disbond	TBD	TBD	-
Cryoflex	II	Proposed	No Disbond	TBD (Control)	TBD	-
Shelf Life	II	Proposed	Acceptance Test	11/2 year	TBD	-
AeroThermal	II	Proposed	No Bare Metal	TBD	TBD	-

\* No Requirement for Orbiter. ET uses 30 psi



# HFC-245fa Blown Foam Qualification Plan

## ACTIONS PLANNED:

- Phase II Qualification Testing (Also In MB0130-149) includes:

MB0130-149 QUALIFICATION

• RAW MATERIALS	• PROCESSING	• SHELF LIFE IN CONTROL AND PAD ENVIRONMENT
<ul style="list-style-type: none"> <li>• Liquid Components                             <ul style="list-style-type: none"> <li>• Foams (A &amp; B)</li> </ul> </li> <li>• Batch Testing</li> <li>• Physical Properties</li> <li>• Component Properties</li> <li>• Mechanical Properties</li> <li>• Cryostrain</li> </ul>	<ul style="list-style-type: none"> <li>• Definition</li> <li>• Foaming Application (Propeller type Mix, Shake &amp; Mix, Semkit Cartridges, Decker Proportioner)</li> <li>• Cleaning</li> <li>• Priming</li> <li>• Full Scale Development</li> </ul>	<ul style="list-style-type: none"> <li>• 6 months, 1, and 1½ years</li> <li>• CORROSION COMPATIBILITY</li> </ul>

## • AERO HEATING/SHEAR (SIMULATE FLIGHT)

- Hot Gas

- Orbiter will Collaborate with ET by Attending 2 Data Sharing Meetings (Need a Common Material that Meets both Specifications)
- In Addition to the MB0 Tests, a Vibration Test of the X1826 and the Current Orbiter Foam Bonded to Primed Substrate in x-, y- and z-axis will be Completed by 2/7/03.
- Upon Completion of the Qualification Testing, the QPL, MB0, MA0, and MPP will be Revised to Incorporate the Utah Products HFC-245fa Blown Foam and Transition the New Foaming Process to Palmdale and KSC

# Foam Qualification Schedule

ID	Task Name	Qtr 2, 20Qtr 3, 20Qtr 4, 20Qtr 1, 20Qtr 2, 20Qtr 3, 20Qtr 4, 20																			
1	Non-141b Foam Qual	Ap	Ma	Ju	Ju	Au	Se	Od	Nd	De	Ja	Fe	Ma	Ap	Ma	Ju	Ju	Au	Se	Od	Nd
2	MCR Approval	4/16																			
3	Obtain Test Materials																				
4	Prepare Test Specimens																				
5	Perform Raw Material Test																				
6	Evaluate Foam Processing																				
7	Evaluate Shelf Life																				
8	Perform Aero Heating Test																				
9	Meet With MSFC																				
10	Final Report																				

---

**RECOMMENDATION(S):**

- Authorize Phase II Qualification Of An EPA Compliant HFC-245fa Blown Foam
- Authorize A Follow-on Of \$50K Initiated Through 2004
  - Includes MB0130-149 and Aero-thermal Testing Performed in '03
  - Includes Extended Shelf Life Testing Performed in '04

---

# Back-Up

- Study Team Members
- Implementation Team Members
- Screening Plan for Potential Foam Candidates
- Test Fixture for the Vibration Test
- PRT Integration Checklist(s)

# Study Team Members

Title of Change: Phase II Qualification of A Non-141b Foam Blowing Agent For Orbiter  
 UCN/MCR No. 23229

KSC	JSC	HUNTINGTON BEACH
NASA 321-867 (xxxx)	NASA 281-4834 (xxxx)	Boeing 714-3724 (xxxx)
	Jeremy Jacobs	Keith Chong Eric Eichinger Joel Slenk David Wells Gerry Kinder
USA 321-861 (xxxx)	USA 281-2824 (xxxx)	
Cris Curtis Cathy Clayton		
Boeing 321-867 (xxxx)	Boeing 281-4834 (xxxx)	OTHER

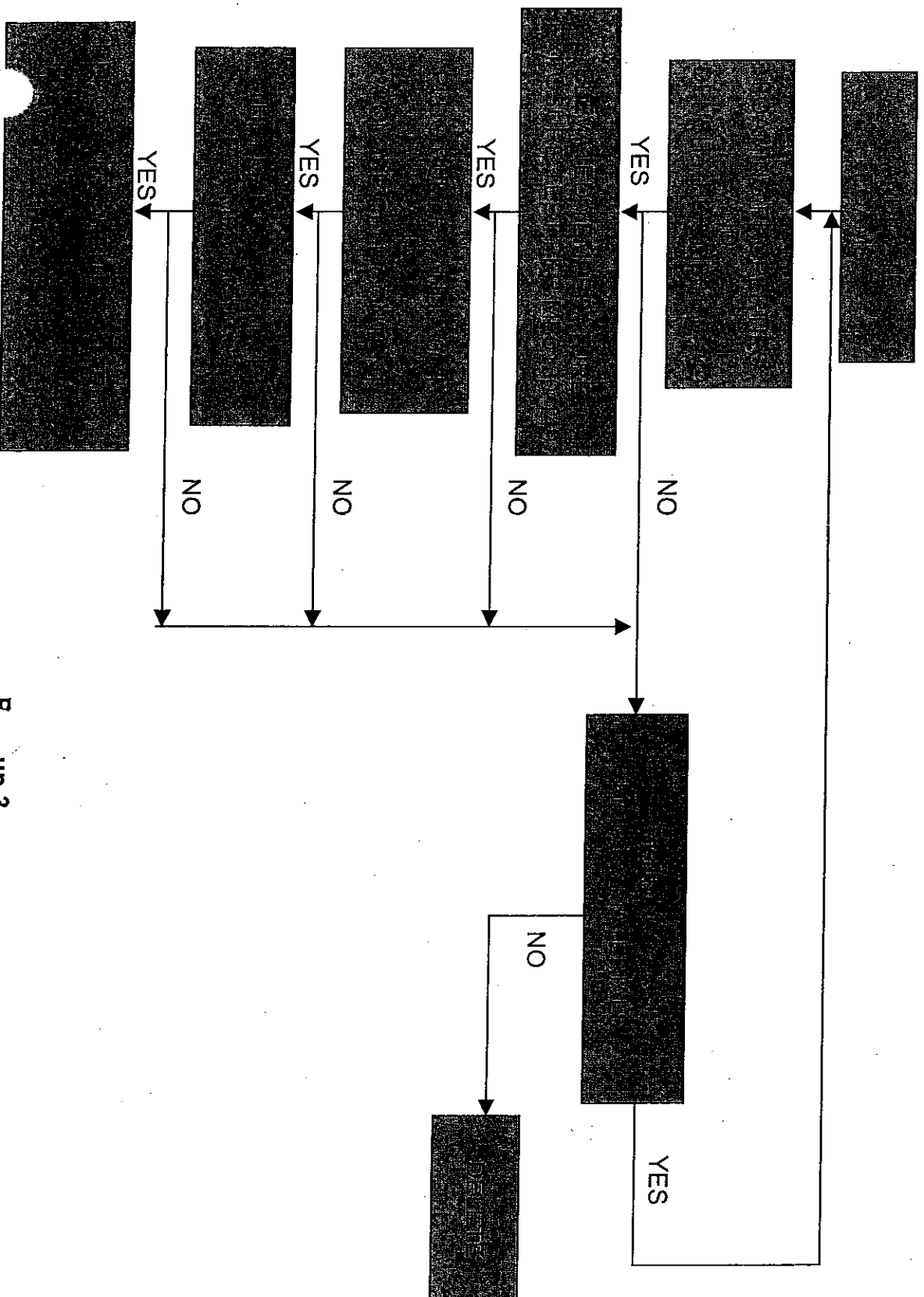
# Implementation Team Members

Title of Change: Phase II Qualification of A Non-141b Foam Blowing Agent For Orbiter  
 UCN/MCR No. 23229

KSC	JSC	HUNTINGTON BEACH
NASA 321-867-(xxxx)	NASA 281-483-(xxxx)	Boeing 714-372-(xxxx)
USA 321-861-(xxxx)	USA 281-282-(xxxx)	
Boeing 321-867-(xxxx)	Boeing 281-483-(xxxx)	OTHER

# Screening Plan for Potential Foam Candidates

- Screened Boeing Potential Foam Candidates From Several Foam Formulators



# Test Fixture for the Vibration Test

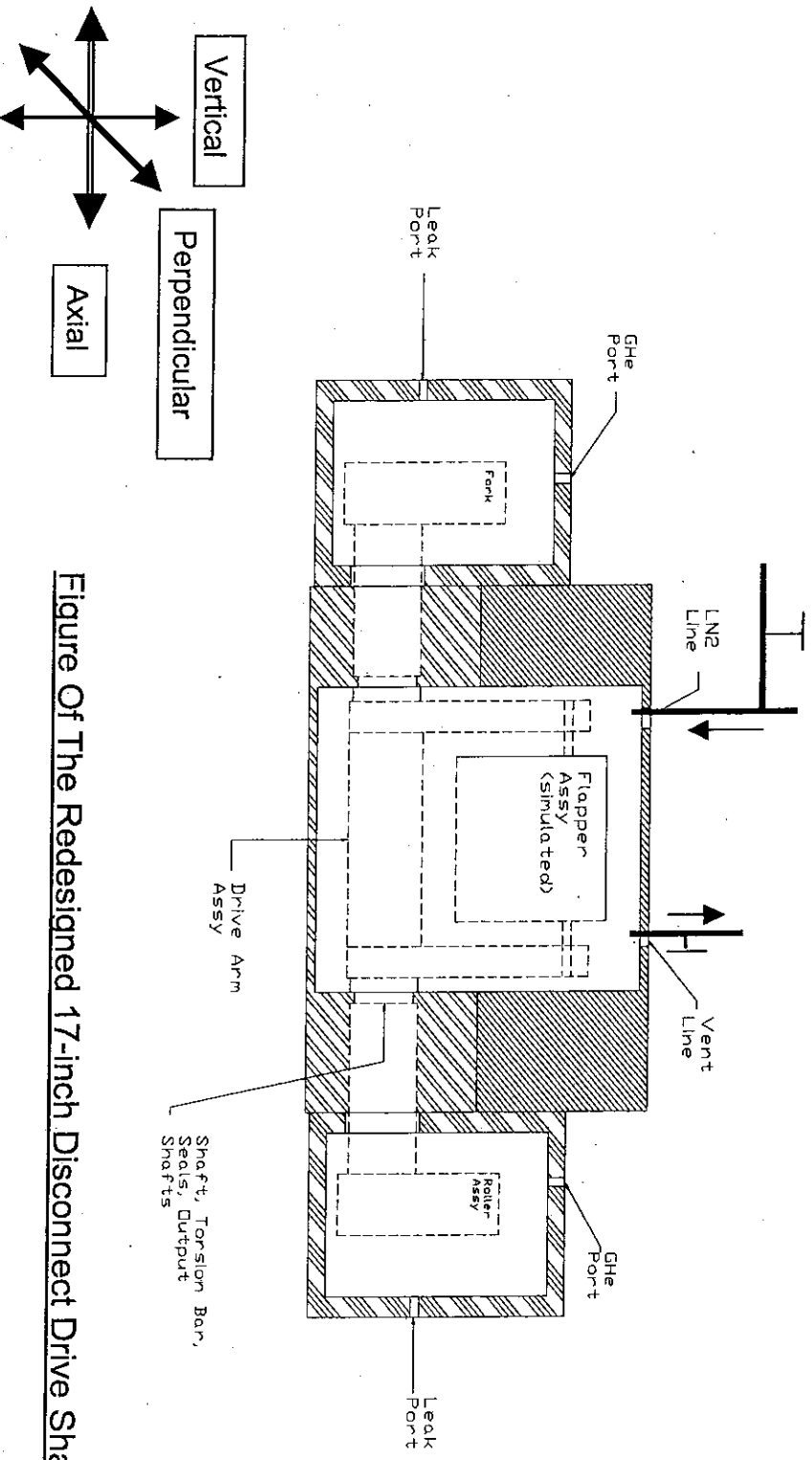


Figure Of The Redesigned 17-inch Disconnect Drive Shaft Seal Test Set-up



# PRT Integration Checklist

Title of Change:  
UCN/MCR No.

Phase II Qualification of A Non-141b Foam Blowing Agent For Orbiter  
23229

Meeting Date:

Meeting Place/Telecon:

Subjects Discussed	
1.	
2.	
3.	
4.	

(X)	Attendance Check	Person's Name	Subject Agreement (Yes/No)			
			(1)	(2)	(3)	(4)
	USA Flight Ops					
	USA Flight Software					
	USA Ground Ops					
	USA Logistics					
	USA Orbiter					
	USA Program Integration					
	USA SR&QA					
	Boeing HDFF					
	Boeing Huntington Beach					
	Boeing LSS					
	Boeing Palmdale					
	Boeing SR&QA					
	NASA SR&QA					

**Michele Lewis**

---

**From:** KOWAL, T. J. (JOHN) (JSC-ES3) (NASA)  
**Sent:** Friday, January 17, 2003 5:00 PM  
**To:** GOMEZ, REYNALDO J. (RAY) (JSC-EG3) (NASA)  
**Subject:** FW: STS-107 Ascent Damage to TPS/RCC

-----Original Message-----

**From:** CURRY, DONALD M. (JSC-ES3) (NASA)  
**Sent:** Friday, January 17, 2003 3:24 PM  
**To:** RICKMAN, STEVEN L. (JSC-ES3) (NASA); KOWAL, T. J. (JOHN) (JSC-ES3) (NASA)  
**Cc:** SCHOMBURG, CALVIN (JSC-EA) (NASA)  
**Subject:** FW: STS-107 Ascent Damage to TPS/RCC

-----Original Message-----

**From:** Chao, Dennis C [mailto:dennis.c.chao@boeing.com]  
**Sent:** Friday, January 17, 2003 2:39 PM  
**To:** Madden, Craig  
**Cc:** Coronado, Diana; Alexander, Ed C; Moon, Darwin G; Norman, Ignacio; Carvajal, Olan; Dunham, Michael J; EXT-Madera, Pamela L; Gordon, Michael P; DERRY, STEPHEN M. (STEVE) (JSC-EG3) (NASA); LEVY, VINCENT M. (JSC-EG) (NASA); CURRY, DONALD M. (JSC-ES3) (NASA); Kinder, Gerald R; Barnwell, Maria M; Rafla, Farid K; Wang, Kuo  
**Subject:** RE: STS-107 Ascent Damage to TPS/RCC

Craig:

I got your web info through Jerry and was reviewing those pictures. From those pictures, it is very hard to tell how bad it is. A minute ago I also received a call from Carlos at KSC. They are reviewing the video tape one more time to decide whether they should turn on action. I am waiting for his call for action.

Dennis

<http://photo4.msfc.nasa.gov/STS/sts107/>  
<<http://photo4.msfc.nasa.gov/STS/sts107/>>

-----Original Message-----

**From:** Madden, Craig  
**Sent:** Friday, January 17, 2003 1:09 PM  
**To:** Chao, Dennis C; Norman, Ignacio  
**Subject:** STS-107 Ascent Damage to TPS/RCC

Dennis/Nacho,  
What have you guys heard about foam/ice impacting the

WLE and TPS?

cm

**Michele Lewis**

---

**From:** MADDEN, CHRISTOPHER B. (CHRIS) (JSC-ES3) (NASA)  
**Sent:** Tuesday, January 21, 2003 11:12 AM  
**To:** CURRY, DONALD M. (JSC-ES3) (NASA); KOWAL, T. J. (JOHN) (JSC-ES3) (NASA)  
**Subject:** FW: STS-107 Debris Analysis Team Plans

-----Original Message-----

**From:** SHACK, PAUL E. (JSC-EA42) (NASA)  
**Sent:** Tuesday, January 21, 2003 9:56 AM  
**To:** SHACK, PAUL E. (JSC-EA42) (NASA); ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA)  
**Cc:** KRAMER, JULIE A. (JSC-EA4) (NASA); MILLER, GLENN J. (JSC-EA) (NASA); RICKMAN, STEVEN L. (JSC-ES3) (NASA); MADDEN, CHRISTOPHER B. (CHRIS) (JSC-ES3) (NASA)  
**Subject:** RE: STS-107 Debris Analysis Team Plans

Somebody else had the same recollection. Here's the ET FRR charts:

-----Original Message-----

**From:** SHACK, PAUL E. (JSC-EA42) (NASA)  
**Sent:** Tuesday, January 21, 2003 9:33 AM  
**To:** ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA)  
**Cc:** KRAMER, JULIE A. (JSC-EA4) (NASA); MILLER, GLENN J. (JSC-EA) (NASA); RICKMAN, STEVEN L. (JSC-ES3) (NASA); MADDEN, CHRISTOPHER B. (CHRIS) (JSC-ES3) (NASA)  
**Subject:** RE: STS-107 Debris Analysis Team Plans

This reminded me that at the STS-113 FRR the ET Project reported on foam loss from the Bipod Ramp during STS-112. The foam (estimated 4X5X12 inches) impacted the ET Attach Ring and dented an SRB electronics box cover.

Their charts stated "ET TPS foam loss over the life of the Shuttle program has never been a 'Safety of Flight' issue". They were severely wirebrushed over this and Brian O'Conner (Associate Administrator for Safety) asked for a hazard assessment for loss of foam.

The suspected cause for foam loss is trapped air pockets which expand due to altitude and aerothermal heating.

-----Original Message-----

**From:** ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)  
**Sent:** Monday, January 20, 2003 8:47 PM  
**To:** SHACK, PAUL E. (JSC-EA42) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA)  
**Cc:** KRAMER, JULIE A. (JSC-EA4) (NASA); MILLER, GLENN J. (JSC-EA) (NASA); RICKMAN, STEVEN L. (JSC-ES3) (NASA); MADDEN, CHRISTOPHER B. (CHRIS) (JSC-ES3) (NASA)  
**Subject:** FW: STS-107 Debris Analysis Team Plans

FYI on forthcoming activity. From USA/Pam Madera and her talking to Boeing contacts:

- It appears that the image folks can only state the impactor is 20 inch max dimension plus/minus 10 inch. It has a max thickness of about 4 inch or so due to the known thicknesses of the ET insulation in the forward bipod area.

## Michele Lewis

---

**From:** ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)  
**Sent:** Friday, January 31, 2003 12:25 PM  
**To:** 'Hoffman, Thomas L'; 'Goodmark, Jeffrey A'  
**Cc:** CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA); CHANG, YUAN-CHYAU, PHD (HARRY) (JSC-ES3) (NASA)  
**Subject:** STS-107 Landing

Tom and Jeff,

I am planning to go the Mission Eval. Room (MER) around 6:45 AM Saturday and join the Landing Team, the Mechanical Team, and/or the Thermal Control Systems team consoles. I am interested in monitoring the real time temperature data from the wheels, landing struts, hydraulic brake lines, and also the tire pressures--with emphasis on the left hand side, and comparing such data output/trends to the right side. This is, of course, related to the ET insulation debris striking the left wing underside during ascent at Mach = 2.6 (81 seconds after launch). As you may know, the NASA/USA/Boeing contractor team made up of multiple technical disciplines performed conservative analyses and we showed no safety-of-flight concerns.

But, I am interested nevertheless in the critical landing and structural/mechanical systems and their real time data displays, such as temperature and pressure. Thanks.

P.S. Question to Harry Chang: Are there real time temp. data displays for the (underside only, not top) wing structure? For example, wing spar caps, skins, RCC panels, etc. Thanks.

Rodney Rocha  
Structural Engineering Division (ES-SED)  
\* ES Div. Chief Engineer (Space Shuttle DCE)  
\* Chair, Space Shuttle Loads & Dynamics Panel  
Mail Code ES2 Phone 281-483-8889

**Michele Lewis**

---

**From:** Robert H. Daugherty [r.h.daugherty@larc.nasa.gov]  
**Sent:** Tuesday, January 28, 2003 1:39 PM  
**To:** CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)  
**Subject:** Tile Damage

Any more activity today on the tile damage or are people just relegated  
to  
crossing their fingers and hoping for the best?  
See ya,  
Bob

**Michele Lewis**

---

**From:** CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)  
**Sent:** Wednesday, January 29, 2003 4:45 PM  
**To:** HAMMERSCHMIDT, MARK M. (JSC-EG4) (NASA)  
**Cc:** LAW, HOWARD G. (JSC-EG) (NASA)  
**Subject:** Two Blown Tire Landing Sim

Mark,

I gathered from Howard today that he may not plan to run a two-blown-tires-before-landing case without direction from the top. Would you consider having someone try this condition in the SES before the landing Saturday?

With the debris impact investigation over, this sim does not now seem to be so necessary, but if it's a cheap sim, it might be worth knowing the answer before the landing.

Carlisle

**Michele Lewis**

---

From: CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)  
Sent: Tuesday, January 28, 2003 2:30 PM  
To: 'Robert H. Daugherty'  
Subject: RE: Tile Damage

I have not heard anything new. I'll let you know if I do.

CCC

-----Original Message-----

From: Robert H. Daugherty [mailto:r.h.daugherty@larc.nasa.gov]  
Sent: Tuesday, January 28, 2003 12:39 PM  
To: CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)  
Subject: Tile Damage

Any more activity today on the tile damage or are people just relegated to crossing their fingers and hoping for the best?  
See ya,  
Bob

**Michele Lewis**

---

**From:** CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)  
**Sent:** Monday, January 27, 2003 4:49 PM  
**To:** 'Robert H. Daugherty'  
**Subject:** RE: Video you sent

Thanks. That's why they need to get all the facts in early on--such as look at impact damage from the spy telescope. Even then, we may not know the real effect of the damage.

The LaRC ditching model tests 20 some years ago showed that the Orbiter was the best ditching shape that they had ever tested, of many. But, our structures people have said that if we ditch we would blow such big holes in the lower panels that the orbiter might break up. Anyway, they refuse to even consider water ditching any more--I still have the test results.

-----Original Message-----

**From:** Robert H. Daugherty [mailto:robert.h.daugherty@nasa.gov]  
**Sent:** Monday, January 27, 2003 3:35 PM  
**To:** CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)  
**Subject:** Video you sent

WOW!!!

I bet there are a few pucker strings pulled tight around there!

Thinking about a belly landing versus bailout..... (I would say that if there is a question about main gear well burn thru that its crazy to even hit the deploy gear button...the reason being that you might have failed the wheels since they are aluminum..they will fail before the tire heating/pressure makes them fail..and you will send debris all over the wheel well making it a possibility that the gear would not even deploy due to ancillary damage...300 feet is the wrong altitude to find out you have one gear down and the other not down...you're dead in that case)

Think about the pitch-down moment for a belly landing when hitting not the main gear but the trailing edge of the wing or body flap when landing gear up...even if you come in fast and at slightly less pitch attitude...the nose slapdown with that pitching moment arm seems to me to be pretty scary....so much so that I would bail out before I would let a loved one land like that.

My two cents.

See ya,

Bob

At 03:04 PM 1/27/2003, you wrote:

-----Original Message-----

**From:** SMITH, JAMES P. (JSC-ES2) (NASA)  
**Sent:** Wednesday, January 22, 2003 7:15 AM  
**To:** DL ES2 Branch; DL ES2 Contractors  
**Subject:** FW: STS-107 Post-Launch Film Review - Day 1

Watch the video first and see if you can spot anything.



**Michele Lewis**

---

**From:** Robert H. Daugherty [robert.h.daugherty@nasa.gov]  
**Sent:** Monday, January 27, 2003 5:02 PM  
**To:** CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)  
**Subject:** Re: FW: Video you sent

I agree completely. Seems to me that the benefit of an EVA to go look at damage has more pros than cons. Can't imagine that an astronaut (even on a crappy tether arrangement) would cause MORE damage than he is going out to look for!

See ya,  
 Bob

At 04:59 PM 1/27/2003, you wrote:

Thanks. That's why they need to get all the facts in early on--such as look at impact damage from the spy telescope. Even then, we may not know the real effect of the damage.

The LaRC ditching model tests 20 some years ago showed that the Orbiter was the best ditching shape that they had ever tested, of many. But, our structures people have said that if we ditch we would blow such big holes in the lower panels that the orbiter might break up. Anyway, they refuse to even consider water ditching any more--I still have the test results[ Bailout seems best.

**From:** Robert H. Daugherty [mailto:robert.h.daugherty@nasa.gov]  
**Sent:** Monday, January 27, 2003 3:35 PM  
**To:** CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)  
**Subject:** Video you sent

WOW!!!

I bet there are a few pucker strings pulled tight around there!  
 Thinking about a belly landing versus bailout..... (I would say that if there is a question about main gear well burn thru that its crazy to even hit the deploy gear button...the reason being that you might have failed the wheels since they are aluminum..they will fail before the tire heating/pressure makes them fail..and you will send debris all over the wheel well making it a possibility that the gear would not even deploy due to ancillary damage...300 feet is the wrong altitude to find out you have one gear down and the other not down...you're dead in that case)

Think about the pitch-down moment for a belly landing when hitting not the main gear but the trailing edge of the wing or body flap when landing gear up...even if you come in fast and at slightly less pitch attitude...the nose slapdown with that pitching moment arm seems to me to be pretty scary...so much so that I would bail out before I would let a loved one land like that.

My two cents.

See ya,  
 Bob

At 03:04 PM 1/27/2003, you wrote:

-----Original Message-----

**From:** SMITH, JAMES P. (JSC-ES2) (NASA)  
**Sent:** Wednesday, January 22, 2003 7:15 AM

3/20/2003

To: DL ES2 Branch; DL ES2 Contractors  
Subject: FW: STS-107 Post-Launch Film Review - Day 1

Watch the video first and see if you can spot anything.

3/20/2003

**Michele Lewis**

---

**From:** LECHNER, DAVID F. (JSC-DF52) (USA)  
**Sent:** Friday, January 31, 2003 1:18 PM  
**To:** 'Robert H. Daugherty'  
**Cc:** M.J.SHUART@larc.nasa.gov; H.M.ADELMAN@larc.nasa.gov; CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)  
**Subject:** RE: Main Gear Breach Concerns

Bob,

I really appreciate the candid remarks. As always your points have generated extremely valuable discussion in our group. Thank you. We have been discussing and continue to discuss the all possible scenarios, signatures and decisions. Your input is beneficial. Like everyone, we hope that the debris impact analysis is correct and all this discussion is mute.

David F-M Lechner  
Space Shuttle Mechanical Systems  
Mechanical, Maintenance, Arm & Crew Systems (MMACS)  
United Space Alliance, Johnson Space Center  
(281) 483-1685

-----Original Message-----

**From:** Robert H. Daugherty [mailto:r.h.daugherty@larc.nasa.gov]  
**Sent:** Thursday, January 30, 2003 5:23 PM  
**To:** LECHNER, DAVID F. (JSC-DF52) (USA)  
**Cc:** M.J.SHUART@larc.nasa.gov; H.M.ADELMAN@larc.nasa.gov; CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)  
**Subject:** Main Gear Breach Concerns

Hi David,

I talked to Carlisle a bit ago and he let me know you guys at MOD were getting into the loop on the tile damage issue. I'm writing this email not really in an official capacity but since we've worked together so many times I feel like I can say pretty much anything to you. And before I begin I would offer that I am admittedly erring way on the side of absolute worst-case scenarios and I don't really believe things are as bad as I'm

getting ready to make them out. But I certainly believe that to not be ready for a gut-wrenching decision after seeing instrumentation in the wheel well not be there after entry is irresponsible. One of my personal theories is that you should seriously consider the possibility of the gear not deploying at all if there is a substantial breach of the wheel well. The reason might be that as the temps increase, the wheel (aluminum) will lose material properties as it heats up and the tire pressure will increase. At some point the wheel could fail and send debris everywhere. While it is true there are thermal fuses in the wheel, if the rate of heating is high enough, since the tire is such a good insulator,

the wheel may degrade in strength enough to let go far below the 1100 psi or so that the tire normally bursts at. It seems to me that with that much

carnage in the wheel well, something could get screwed up enough to prevent deployment and then you are in a world of hurt. The following are scenarios that might be possible...and since there are so many of them, these are offered just to make sure that some things don't slip thru the cracks...I suspect many or all of these have been gone over by you guys already:

1. People talk about landing with two flat tires...I did too until this

came up. If both tires blew up in the wheel well (not talking thermal fuse and venting but explosive decomp due to tire and/or wheel failure) the overpressure in the wheel well will be in the 40 + psi range. The resulting loads on the gear door ( a quarter million lbs) would almost certainly blow the door off the hinges or at least send it out into the slip stream...catastrophic. Even if you could survive the heating, would the gear now deploy? And/or also, could you even reach the runway with this kind of drag?

2. The explosive bungies...what might be the possibility of these firing due to excessive heating? If they fired, would they send the gear door and/or the gear into the slipstream?

3. What might excessive heating do to all kinds of other hardware in the wheel well...the hydraulic fluid, uplocks, etc? Are there vulnerable hardware items that might prevent deployment?

4. If the gear didn't deploy ( and you would have to consider this before making the commitment to gear deploy on final) what would happen control-wise if the other gear is down and one is up? (I think Howard Law

and his community will tell you you're finished)

5. Do you belly land? Without any other planning you will have already

committed to KSC. And what will happen during derotation in a gear up landing (trying to stay away from an asymmetric gear situation for example) since you will be hitting the aft end body flap and wings and pitching down

extremely fast a la the old X-15 landings? My guess is you would have an

extremely large vertical decel situation up in the nose for the crew. While directional control would be afforded in some part by the drag

chute...do you want to count on that to keep you out of the moat?

6. If a belly landing is unacceptable, ditching/bailout might be next on the list. Not a good day.

7. Assuming you can get to the runway with the gear deployed but with two

flat tires, can the commander control the vehicle both in pitch and lateral

directions? One concern is excessive drag (0.2 g's) during TD throughout

the entire saddle region making the derotation uncontrollable due to saturated elevons...resulting in nose gear failure? The addition of crosswinds would make lateral control a tough thing too. Simulating this,

because it is so ridiculously easy to do (sims going on this very minute at AMES with load-persistence) seems like a real no-brainer.

Admittedly this is over the top in many ways but this is a pretty bad

time  
to get surprised and have to make decisions in the last 20 minutes. You

can count on us to provide any support you think you need.

Best Regards,

Bob

## Michele Lewis

---

From: Hoffman, Thomas L [Thomas.L.Hoffman@boeing.com]  
Sent: Thursday, January 23, 2003 4:49 PM  
To: LECHNER, DAVID F. (JSC-DF52) (USA)  
Subject: RE: STS-107 Landing Weight Status

Dave,  
Thanks for the information. I wasn't aware of the possible 4 day extension. That would salvage that weekend!  
BTW The way I understand it if the mission is extended beyond 18 days then this pushes the envelope for landing test data gathered. These are in the EDO category and there is a reduction in the flight rules for crosswind to 12 kt maximum to account for possible pilot fatigue/long exposure to zero g, etc. I think I saw this buried in flight rule A2-6.  
TH

-----Original Message-----

From: LECHNER, DAVID F. (JSC-DF52) (USA)  
[mailto:david.f.lechner1@jsc.nasa.gov]  
Sent: Thursday, January 23, 2003 3:22 PM  
To: Hoffman, Thomas L  
Subject: STS-107 Landing Weight Status

Tom,

Several variables have lead to an increase over predicted prelaunch down weights (including launching into a higher orbit thus requiring less burns, better cooling with radiators than expected, ect...) Without any corrective actions, current predictions calculate a down weight violation by 657 lbs violating the 233,000 lbs down weight spec. This equates to a worst case End Of Mission (EOM) weight of 233,657 lbs with an X-c.g. of 1079.93 inches.

The c.g. has actually moved aft, improving the EOM pressures for the Main Landing Gear tires. Current tire pressures and temperatures for NEOM are 333 psi / 9 deg F and Anytime Deorbit of 305 psi / -28 deg F.

Since cryo and prop weight are dynamic while on-orbit, no decision will be made until Landing-4 days. Additionally, talks of 4 days extension are circulating. Extension days, of course, would eliminate the situation entirely.

The increase over pre-mission values include: 600 lbs prop, 408 lbs cryo and 85 lbs non-prop for an KSC Orbit 255 opportunity. Several options are available to reduce cryo including operation of prop pod heaters, high-load EECOM duct heaters and hydraulic circ pumps. Prop dumps can also be made prior to entry.

More of the story will unfold at L-4 days. There are several options with minimum time impacts to eliminate down weight concerns.

David F-M Lechner  
Space Shuttle Mechanical Systems  
Mechanical, Maintenance, Arm & Crew Systems (MMACS)  
United Space Alliance, Johnson Space Center  
(281) 483-1685

## Michele Lewis

---

**From:** CHANG, YUAN-CHYAU, PHD (HARRY) (JSC-ES3) (NASA)  
**Sent:** Friday, January 31, 2003 3:26 PM  
**To:** 'Hoffman, Thomas L'; 'Goodmark, Jeffrey A'; ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)  
**Cc:** CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA); 'Nguyen, Than X'; 'Russell, David J'; 'Davies, Tim'  
**Subject:** RE: STS-107 Landing

There are only 2 lower wing structure temperature MSID's (port V09T1002, stbd V09T1000). I have temperature plots for all MLG compartment MSID's for STS-109 (last OV-102 mission) and schematics indicating MSID locations in the MER. Tom and Jeff should have XGOAL display and can use it to plot for real-time monitoring. If you need Thermal help, just call X33919.

---

**From:** ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)  
**Sent:** Friday, January 31, 2003 11:24 AM  
**To:** 'Hoffman, Thomas L'; 'Goodmark, Jeffrey A'  
**Cc:** CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA); CHANG, YUAN-CHYAU, PHD (HARRY) (JSC-ES3) (NASA)  
**Subject:** STS-107 Landing

Tom and Jeff,

I am planning to go the Mission Eval. Room (MER) around 6:45 AM Saturday and join the Landing Team, the Mechanical Team, and/or the Thermal Control Systems team consoles. I am interested in monitoring the real time temperature data from the wheels, landing struts, hydraulic brake lines, and also the tire pressures--with emphasis on the left hand side, and comparing such data output/trends to the right side. This is, of course, related to the ET insulation debris striking the left wing underside during ascent at Mach = 2.6 (81 seconds after launch). As you may know, the NASA/USA/Boeing contractor team made up of multiple technical disciplines performed conservative analyses and we showed no safety-of-flight concerns.

But, I am interested nevertheless in the critical landing and structural/mechanical systems and their real time data displays, such as temperature and pressure. Thanks.

P.S. Question to Harry Chang: Are there real time temp. data displays for the (underside only, not top) wing structure? For example, wing spar caps, skins, RCC panels, etc. Thanks.

Rodney Rocha

Structural Engineering Division (ES-SED)

\* ES Div. Chief Engineer (Space Shuttle DCE)

\* Chair, Space Shuttle Loads & Dynamics Panel

Mail Code ES2 Phone 281-483-8889



**From:** CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)  
**Sent:** Wednesday, January 22, 2003 5:13 PM  
**To:** 'Hoffman, Thomas L'  
**Subject:** RE: STS-107 Post-Launch Film Review - Day 1

-----Original Message-----

that's amazing footage. I hope the tiles are OK (like I'm the only one concerned?)

-----Original Message-----

**From:** CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA) [mailto:carlisle.c.campbell@nasa.gov]  
**Sent:** Wednesday, January 22, 2003 2:52 PM  
**To:** Porter, Michael T; Hoffman, Thomas L  
**Subject:** FW: STS-107 Post-Launch Film Review - Day 1

-----Original Message-----

**From:** SMITH, JAMES P. (JSC-ES2) (NASA)  
**Sent:** Wednesday, January 22, 2003 7:15 AM  
**To:** DL ES2 Branch; DL ES2 Contractors  
**Subject:** FW: STS-107 Post-Launch Film Review - Day 1

Watch the video first and see if you can spot anything.

-----Original Message-----

**From:** Pedraza, Michael A [mailto:michael.a.pedraza@usago.ksc.nasa.gov]  
**Sent:** Tuesday, January 21, 2003 8:35 PM  
**Subject:** STS-107 Post-Launch Film Review - Day 1

**Michael Pedraza**  
Storekeeper/Expediter  
MSC-44 RPSF  
USK-337  
Phone 861-6452  
Fax 861-0374

« \*Supply & Support\* »



Attached is the Day 1 report and an MPG of Anomaly #1.

**From:** HALLIDAY, ROBERT W. (DOC) (JSC-NC) (GHG)  
**Sent:** Friday, January 31, 2003 2:34 PM  
**To:** CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)  
**Subject:** RE: STS-107 Post-Launch Film Review - Day 1

**From:** CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)  
**Sent:** Friday, January 31, 2003 1:26 PM  
**To:** HALLIDAY, ROBERT W. (DOC) (JSC-NC) (GHG)  
**Subject:** FW: STS-107 Post-Launch Film Review - Day 1

**From:** SMITH, JAMES P. (JSC-ES2) (NASA)  
**Sent:** Wednesday, January 22, 2003 7:15 AM  
**To:** DL ES2 Branch; DL ES2 Contractors  
**Subject:** FW: STS-107 Post-Launch Film Review - Day 1

**From:** Pedraza, Michael A [mailto:michael.a.pedraza@usago.ksc.nasa.gov]  
**Sent:** Tuesday, January 21, 2003 8:35 PM  
**Subject:** STS-107 Post-Launch Film Review - Day 1

« **Supply & Support** »



Attached is the Day 1 report and an MPG of Anomaly #1.

**Michele Lewis**

---

**From:** SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA)  
**Sent:** Thursday, January 30, 2003 5:58 PM  
**To:** SHACK, PAUL E. (JSC-EA42) (NASA)  
**Subject:** Emails and briefings on debris impact

Paul,

Just for the record, here is what Carlisle sent out to MOD (Doremus) when asked:



FW: STS-107 FW: STS-107 FW: STS-107 FW: STS-107  
st-Launch Film Ebris Analysis Tebris Briefing fong Debris Impact

Joyce

***Joyce M. Seriale-Grush***

*Shuttle Engineering Office/EA42*

*Phone: 281-483-4542*

*Fax: 281-483-2965*

## Michele Lewis

---

From: SHACK, PAUL E. (JSC-EA42) (NASA)  
Sent: Monday, January 27, 2003 1:31 PM  
To: KOWAL, T. J. (JOHN) (JSC-ES3) (NASA); ORTIZ-LONGO, CARLOS R., PHD (JSC-EA4) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA)  
Subject: RE: STS-107 Post-Launch Film Review - Day 1

82 seconds, Mach 2.6. The foam density is 2. \_ lb/ft^3; supposedly not a threat to RCC per Calvin and Curry.

-----Original Message-----

From: KOWAL, T. J. (JOHN) (JSC-ES3) (NASA)  
Sent: Monday, January 27, 2003 12:04 PM  
To: ORTIZ-LONGO, CARLOS R., PHD (JSC-EA4) (NASA); SHACK, PAUL E. (JSC-EA42) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA)  
Subject: RE: STS-107 Post-Launch Film Review - Day 1

All I've heard is Mach 2.5.

John Kowal  
ES3/Thermal Branch  
NASA-Johnson Space Center  
(281) 483-8871

-----Original Message-----

From: ORTIZ-LONGO, CARLOS R., PHD (JSC-EA4) (NASA)  
Sent: Monday, January 27, 2003 11:48 AM  
To: SHACK, PAUL E. (JSC-EA42) (NASA); KOWAL, T. J. (JOHN) (JSC-ES3) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA)  
Subject: RE: STS-107 Post-Launch Film Review - Day 1

This is, certainly, the largest one I have seen hit the Orbiter. The size and density of the debris cloud tells me that the hit is probably large in surface area but shallow. In the other two more significant hits I remember, the debris clouds were both narrow and "dense" (more resembling a con-trail). When the Orbiters came back, the hits were narrow, long, and deep. At what time or altitude did this occur?

C

-----Original Message-----

From: SHACK, PAUL E. (JSC-EA42) (NASA)  
Sent: Monday, January 27, 2003 8:56 AM  
To: ORTIZ-LONGO, CARLOS R., PHD (JSC-EA4) (NASA)  
Subject: FW: STS-107 Post-Launch Film Review - Day 1

top view

-----Original Message-----

From: SCHOMBURG, CALVIN (JSC-EA) (NASA)  
Sent: Tuesday, January 21, 2003 9:26 AM  
To: SHACK, PAUL E. (JSC-EA42) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA); HAMILTON, DAVID A. (DAVE) (JSC-EA) (NASA)  
Subject: FW: STS-107 Post-Launch Film Review - Day 1

FYI-TPS took a hit-should not be a problem-status by end of week.

-----Original Message-----

From: Oliu-1, Armando [mailto:Armando.Oliu-1@nasa.gov]  
Sent: Friday, January 17, 2003 6:08 PM  
To: Abner, Charlie; ADAMS, RANDALL W. (JSC-MA2) (NASA); 'Ayotte, William'; Blue, John B; BROWN, KENNETH L. (JSC-MV6) (NASA); 'Buckingham, Bruce'; Bulloch-1, Steve; Bursian, Henry; BYRNE, GREGORY J., PHD (JSC-SX) (NASA); Chitko, Pete J.; 'cookjh@thiokol.com'; DERRY, STEPHEN M. (STEVE) (JSC-EG3) (NASA); DISLER, JONATHAN M. (JON) (JSC-SX) (LM); DISLER, JONATHAN M. (JON) (JSC-SX) (LM); 'Eastwood Martin'; Estrada-1, Carlos; FRICKE, ROBERT W., JR (JSC-MV) (LM); GAETJENS, WILLIAM M. (JSC-CB) (USA); Glenn-1, Malcolm; GOMEZ, REYNALDO J. (RAY) (JSC-EG3) (NASA); 'GRP DOC Mission Support Room'; Guidi-1, John; Hawkins, Tyrell; Herman, Robert S; Herst, Terri; Holloway, Darrell L; 'Holmes Steve'; Huff, Joy N.; 'Jay.Sambamurthi@msfc.nasa.gov'; Jones-1, Frank; Kelley-1, David; 'Khodadoust, Abdollah'; Kienitz, Fred; 'Kinder Gerald'; 'Koenig Lisa'; 'Kopfing, Philip A'; Lafleur, Tom C; Leggett, Kenneth D; Leinbach-1, Mike; HAM, LINDA J. (JSC-MA2) (NASA); 'Mango, Ed'; 'McClymonds, Jack'; MCCORMACK, DONALD L. (DON) (JSC-MV6) (NASA); Mosteller-1, Ted; Mulligan-1, Melanie; Nguyen-1, Bao; 'O'Farrell Mike'; ORTIZ-LONGO, CARLOS R., PHD (JSC-EA4) (NASA); 'Otte Neil'; 'Otto, Scott'; 'Page, Robert'; Payne-1, Michael; 'Ramirez, Juan'; Revay, Kenneth P; 'Rieckhoff, Tom - PC'; 'Rieckhoff, Tom - UNIX'; ROE, RALPH R. (JSC-MV) (NASA); SCHOMBURG, CALVIN (JSC-EA) (NASA); 'Schricker, B.'; 'snichols@hq.nasa.gov'; Sofge, Al (NASA HQ); 'Speece, Robert'; Stevenson-1, Charlie; 'Stone, Jeff'; Tenbusch-1, Ken; Wells-1, Joel; Wilson, Thomas F.; Rivera, Jorge; Greenwell-1, Shawn; Oliu-1, Armando; Crisafulli, Anthony; Brewer, Raymond J; Marren, Tom; Thompson-1, Becky J.; Key, John; Lorick, Vicky K; Champagne, Lorraine C; Kent, William T. "Tim"; Spaulding-1, Jeff; Altemus-1, Steve; Mullins, Michael B; Powell, Doug; Cross, Donald G; Hammel-1, Donald; Stoner-1, Michael D; Greby, Mark J  
Subject: STS-107 Post-Launch Film Review - Day 1

Attached is the Day 1 report and an MPG of Anomaly #1.

<<107film1.pdf>> <<E212.mpg>>

## Michele Lewis

**From:** ORTIZ-LONGO, CARLOS R., PHD (JSC-EA4) (NASA)  
**Sent:** Monday, January 27, 2003 12:48 PM  
**To:** SHACK, PAUL E. (JSC-EA42) (NASA); KOWAL, T. J. (JOHN) (JSC-ES3) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA)  
**Subject:** RE: STS-107 Post-Launch Film Review - Day 1

This is, certainly, the largest one I have seen hit the Orbiter. The size and density of the debris cloud tells me that the hit is probably large in surface area but shallow. In the other two more significant hits I remember, the debris clouds were both narrow and "dense" (more resembling a con-trail). When the Orbiters came back, the hits were narrow, long, and deep. At what time or altitude did this occurred?

C

-----Original Message-----

**From:** SHACK, PAUL E. (JSC-EA42) (NASA)  
**Sent:** Monday, January 27, 2003 8:56 AM  
**To:** ORTIZ-LONGO, CARLOS R., PHD (JSC-EA4) (NASA)  
**Subject:** FW: STS-107 Post-Launch Film Review - Day 1

top view

-----Original Message-----

**From:** SCHOMBURG, CALVIN (JSC-EA) (NASA)  
**Sent:** Tuesday, January 21, 2003 9:26 AM  
**To:** SHACK, PAUL E. (JSC-EA42) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA); HAMILTON, DAVID A. (DAVE) (JSC-EA) (NASA)  
**Subject:** FW: STS-107 Post-Launch Film Review - Day 1

FYI-TPS took a hit-should not be a problem-status by end of week.

-----Original Message-----

**From:** Oliu-1, Armando [mailto:Armando.Oliu-1@nasa.gov]  
**Sent:** Friday, January 17, 2003 6:08 PM  
**To:** Abner, Charlie; ADAMS, RANDALL W. (JSC-MA2) (NASA); 'Ayotte, William'; Blue, John B; BROWN, KENNETH L. (JSC-MV6) (NASA); 'Buckingham, Bruce'; Bulloch-1, Steve; Bursian, Henry; BYRNE, GREGORY J., PHD (JSC-SX) (NASA); Chitko, Pete J.; 'cookjh@thiokol.com'; DERRY, STEPHEN M. (STEVE) (JSC-EG3) (NASA); DISLER, JONATHAN M. (JON) (JSC-SX) (LM); DISLER, JONATHAN M. (JON) (JSC-SX) (LM); 'Eastwood Martin'; Estrada-1, Carlos; FRICKE, ROBERT W., JR (JSC-MV) (LM); GAETJENS, WILLIAM M. (JSC-CB) (USA); Glenn-1, Malcolm; GOMEZ, REYNALDO J. (RAY) (JSC-EG3) (NASA); 'GRP DOC Mission Support Room'; Guidi-1, John; Hawkins, Tyrell; Herman, Robert S; Herst, Terri; Holloway, Darrell L; 'Holmes Steve'; Huff, Joy N.; 'Jay.Sambamurthi@msfc.nasa.gov'; Jones-1, Frank; Kelley-1, David; 'Khodadoust, Abdollah'; Kienitz, Fred; 'Kinder Gerald'; 'Koenig Lisa'; 'Kopfing, Philip A'; Lafleur, Tom C; Leggett, Kenneth D; Leinbach-1, Mike; HAM, LINDA J. (JSC-MA2) (NASA); 'Mango, Ed'; 'McClymonds, Jack'; MCCORMACK, DONALD L. (DON) (JSC-MV6) (NASA); Mosteller-1, Ted; Mulligan-1, Melanie; Nguyen-1, Bao; 'O'Farrell Mike'; ORTIZ-LONGO, CARLOS R., PHD (JSC-EA4) (NASA); 'Otte Neil'; 'Otto, Scott'; 'Page, Robert'; Payne-1, Michael; 'Ramirez, Juan'; Revay, Kenneth P; 'Rieckhoff, Tom - PC'; 'Rieckhoff, Tom - UNIX'; ROE, RALPH R. (JSC-MV) (NASA); SCHOMBURG, CALVIN (JSC-EA) (NASA); 'Schrick, B.'; 'snichols@hq.nasa.gov'; Sofge, Al (NASA HQ); 'Speece, Robert'; Stevenson-1, Charlie; 'Stone, Jeff'; Tenbusch-1, Ken; Wells-1, Joel; Wilson, Thomas F.; Rivera, Jorge; Greenwell-1, Shawn; Oliu-1, Armando; Crisafulli, Anthony; Brewer, Raymond J; Marren, Tom; Thompson-1, Becky



J.; Key, John; Lorick, Vicky K; Champagne, Lorraine C; Kent, William T.  
"Tim"; Spaulding-1, Jeff; Altemus-1, Steve; Mullins, Michael B; Powell,  
Doug; Cross, Donald G; Hammel-1, Donald; Stoner-1, Michael D; Greby,  
Mark J

Subject: STS-107 Post-Launch Film Review - Day 1

Attached is the Day 1 report and an MPG of Anomaly #1.

<<107film1.pdf>> <<E212.mpg>>

## Michele Lewis

---

**From:** ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)  
**Sent:** Sunday, January 26, 2003 8:45 PM  
**To:** SHACK, PAUL E. (JSC-EA42) (NASA); MCCORMACK, DONALD L. (DON) (JSC-MV6) (NASA); OUELLETTE, FRED A. (JSC-MV6) (NASA)  
**Cc:** ROGERS, JOSEPH E. (JOE) (JSC-ES2) (NASA); GALBREATH, GREGORY F. (GREG) (JSC-ES2) (NASA); JACOBS, JEREMY B. (JSC-ES4) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA); KRAMER, JULIE A. (JSC-EA4) (NASA); CURRY, DONALD M. (JSC-ES3) (NASA); KOWAL, T. J. (JOHN) (JSC-ES3) (NASA); RICKMAN, STEVEN L. (JSC-ES3) (NASA); SCHOMBURG, CALVIN (JSC-EA) (NASA); CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)  
**Subject:** STS-107 Wing Debris Impact on Ascent: Final analysis case completed

As you recall from Friday's briefing to the MER, there remained open work to assess analytically predicted impact damage to the wing underside in the region of the main landing gear door. This area was considered a low probability hit area by the image analysis teams, but they admitted a debris strike here could not be ruled out.

As with the other analyses performed and reported on Friday, this assessment by the Boeing multi-technical discipline engineering teams also employed the system integration's dispersed trajectories followed by serial results from the *Crater* damage prediction tool, thermal analysis, and stress analysis. It was reviewed and accepted by the ES-DCE (R. Rocha) by Sunday morning, Jan. 26. The case is defined by a large area gouge about 7 inch wide and about 30 inch long with sloped sides like a crater, and reaching down to the densified layer of the TPS.

**SUMMARY:** Though this case predicted some higher temperatures at the outer layer of the honeycomb aluminum face sheet and subsequent debonding of the sheet, there is no predicted burn-through of the door, no breeching of the thermal and gas seals, nor is there door structural deformation or thermal warpage to open the seal to hot plasma intrusion. Though degradation of the TPS and door structure is likely (if the impact occurred here), there is no safety of flight (entry, descent, landing) issue.

Note to Don M. and Fred O.: On Friday I believe the MER was thoroughly briefed and it was clear that open work remained (viz., the case summarized above), the message of open work was not clearly given, in my opinion, to Linda Ham at the MMT. I believe we left her the impression that engineering assessments and cases were all finished and we could state with finality no safety of flight issues or questions remaining. This very serious case could not be ruled out and it was a very good thing we carried it through to a finish.

### Rodney Rocha (ES2) x38889

- Division Shuttle Chief Engineer (DCE), ES-Structural Engineering Division
- Chair, Space Shuttle Loads & Dynamics Panel

**Michele Lewis**

---

**From:** SHACK, PAUL E. (JSC-EA42) (NASA)  
**Sent:** Tuesday, January 21, 2003 10:33 AM  
**To:** ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA)  
**Cc:** KRAMER, JULIE A. (JSC-EA4) (NASA); MILLER, GLENN J. (JSC-EA) (NASA); RICKMAN, STEVEN L. (JSC-ES3) (NASA); MADDEN, CHRISTOPHER B. (CHRIS) (JSC-ES3) (NASA)  
**Subject:** RE: STS-107 Debris Analysis Team Plans

This reminded me that at the STS-113 FRR the ET Project reported on foam loss from the Bipod Ramp during STS-112. The foam (estimated 4X5X12 inches) impacted the ET Attach Ring and dented an SRB electronics box cover.

Their charts stated "ET TPS foam loss over the life of the Shuttle program has never been a 'Safety of Flight' issue". They were severely wirebrushed over this and Brian O'Conner (Associate Administrator for Safety) asked for a hazard assessment for loss of foam.

The suspected cause for foam loss is trapped air pockets which expand due to altitude and aerothermal heating.

-----Original Message-----

**From:** ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)  
**Sent:** Monday, January 20, 2003 8:47 PM  
**To:** SHACK, PAUL E. (JSC-EA42) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA)  
**Cc:** KRAMER, JULIE A. (JSC-EA4) (NASA); MILLER, GLENN J. (JSC-EA) (NASA); RICKMAN, STEVEN L. (JSC-ES3) (NASA); MADDEN, CHRISTOPHER B. (CHRIS) (JSC-ES3) (NASA)  
**Subject:** FW: STS-107 Debris Analysis Team Plans

FYI on forthcoming activity. From USA/Pam Madera and her talking to Boeing contacts:

- It appears that the image folks can only state the impactor is 20 inch max dimension plus/minus 10 inch. It has a max thickness of about 4 inch or so due to the known thicknesses of the ET insulation in the forward bipod area.
- Boeing Load/Stress group is researching if such insulation impacts are in the data base of previous impact tests on Orbiter TPS.

**Rodney Rocha**

- **Division Chief Engineer (DCE), ES-Structural Engineering Division**
- **Chair, Space Shuttle Loads & Dynamics Panel**
- **Mail Code ES2            x38889**

: Madera, Pamela L [mailto:pam.l.madera@usahq.unitedspacealliance.com]

**Sent:** Monday, January 20, 2003 5:47 PM

**To:** CURRY, DONALD M. (JSC-ES3) (NASA); ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA); LEVY, VINCENT M. (JSC-EG) (NASA); KOWAL, T. J. (JOHN) (JSC-ES3) (NASA); DERRY, STEPHEN M. (STEVE) (JSC-EG3) (NASA)

**Cc:** 'Scott Christensen V (E-mail)'; 'Norman Ignacio (Nacho) (E-mail)'; CHAO, DENNIS; Stoner-1, Michael D; 'Carlos Ortiz (E-mail)'; 'Michael J Dunham (E-mail)'; Sebesta, Stephen P; CORONADO, DIANA; 'Craig Madden' (E-mail); Bell, Dan R.; Gordon, Michael P.; Paul A Parker (E-mail)

**Subject:** STS-107 Debris Analysis Team Plans